Pinna deltodes Menke newly described and differentiated from *P. bicolor* Gmelin (Bivalvia, Pterioida)*

Amelie Scheltema

Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543 USA

*Contribution number 5167 from the Woods Hole Oceanographic Institution

ABSTRACT

Pinna deltodes Menke is a valid Indo-Pacific species of Pinnidae morphologically similar to *P. bicolor* Gmelin. It can be distinguished from *P. bicolor* in Australia by the presence of regular, sharply defined, pinkish-buff lateral bands of subepithelial gland cells along the inner fold of the posterior mantle margin and by the position of the posterior adductor muscle scar at the posterior edge of the dorsal nacreous layer. The subepithelial gland cells are coarsely granular; they are not acid or neutral muco-polysaccharides (mucins) or muco-glycoproteins (mucoids). The preferred habitat of *P. deltodes* is a hard substrate, either within cobble flats or beneath boulders, coral blocks, and bombies. The species extends off eastern Africa to eastern Australia and as far north as Pakistan and probably the Red Sea, from the intertidal zone to 14 0m.

INTRODUCTION

The Pinnidae, or razor, pen, wing, or fan shells, is a family of large wedge-shaped bivalves that live in mud and sand or amongst rocks or corals. The flared posterior edge of the shell projects beyond the substrate; the buried anterior end is attached to solid objects by a mass of long byssus threads. The Pinnidae inhabit tropical and temperate waters of the world.

Monographs on the Pinnidae by Turner and Rosewater (1958) and Rosewater (1961) brought much needed taxonomic order to Recent members of the family, which vary greatly in shell morphology and have a wide geographic distribution. Of the original 175 specific names in the literature (Winckworth, 1929, *in* Turner and Rosewater, 1958), Rosewater (1961) recognized twenty valid Recent species and subspecies in three genera.

Pinna bicolor Gmelin is a common Indo-Pacific species. Rosewater (1961) synonymized 31 species names under *P. bicolor*, including the fossil *P. inermis* Tate, *P. menkei* 'Hanley' Reeve, *P. madida* Reeve, *P. attenuata* Reeve, *P. fumata* Reeve, *P. dolobrata* Lamarck, *P. moluccensis* Clessin, *P. isosceles* Hedley, and *P. atropurpurea* Sowerby. Also included

were four specific names that referred to a 'short, wide form of *bicolor*' (Rosewater, 1961: 198); the earliest name for this form is *P. deltodes* Menke.

Since the publication of Rosewater's monograph, many specimens of Pinnidae have been added to the mollusc collection of the Australian Museum (Sydney), including preserved entire animals with accompanying field data. From this new material and from collections made in Townsville, Queensland, *P. deltodes* Menke is here shown to be a valid species morphologically very similar to *P. bicolor*.

Pinna deltodes Menke (Figs. 1-7)

Synonymy

1843. *Pinna deltodes* Menke, Molluscorum Novae Hollandiae Specimen, p. 37 (prope Victoria River). [Type figure Reeve, 1858, Conchologia Iconica, XI, *Pinna*, Pl. 21, Fig. 4 0, by subsequent designation, Rosewater, 1961; figured specimen Brit. Mus. (NH).]
1924. *Pinna scapula* Hedley, Rec. Australian Mus. 14: 148, pl. 19, figs. 6, 7 (Northern Territory: Darwin). [Holotype Australian Museum.]
1939. *Exitopinna deltodes ultra* Iredale, Gr. Barrier Reef Exp. Sci. Repts. 5: 315 (Low Isles, Qld.). [Holotype Australian Museum; figured in Rosewater, 1961, pl. 15 0.]

Description

Maximum shell length and width 37 cm and 21 cm, respectively (Fig. 6). In specimens longer than 12 cm, valves usually fan-shaped; dorsal and ventral margins nearly equal in length and about three-quarters greatest shell length. Shell width about three-quarters shell length (Fig. 4). Posterior shell margin rises in high, symmetrical arch, with highest point, and thus greatest shell length, midway between dorsal and ventral margins. Shell thick and flattened, foliate, lamellose, and without spines even in juveniles. In shells less than 12 cm, dorsal margin usually longer than ventral margin; about ten radiating ribs present which are preserved at anterior end of larger shells. Shells may be extremely flared posteriorly so that width nearly equals length. Shell colour horn; internally, smoky horn. Sulcus separating dorsal and ventral nacreous lobes wide, 3 to 1 0 mm at its greatest width (see Fig. 4). Ventral lobe rounded and either shorter or longer than truncated dorsal lobe. Posterior adductor muscle touches posterior edge of dorsal lobe, even in small specimens, and is usually anterior to midpoint of valve.

Pinkish-buff, regularly spaced, lateral bands along inner mantle fold distinguishing character; less regular bands occur throughout mantle lobe posterior to waste canal (Figs. 1A, 2). 'Eyes of Will' (Fig. 3; Rosewater, 1961) not closely spaced. Pallial organ with long conical head as in other species of *Pinna* and in *Streptopinna* (Fig. 1A).

Distribution

Pinna deltodes is an Indo-Pacific species ranging from east Africa to eastern Australia and Lord Howe Island and northward to Pakistan, southern India, and the Indo-Malay Archipelago. In Australia the species is distributed along the west coast from about 24°S northward, along the north coast, on the Great Barrier Reef, and south of the Reef to about 35°S.

Specimens Examined

From Australian localities — Western Australian Museum, records from Western Australia (examined by S.M. Slack-Smith): Woorora Station via Carnarvon (southernmost record, west coast); Exmouth Gulf; Barrow Is.; Dampier Archipelago; Port Hedland; Broome; Admiralty Gulf.

Australian Museum (Sydney) (number of specimens is within parentheses; asterisk denotes that soft parts were examined): Broome, W.A. (7); Vansittart Bay, W.A. (1); West Point, Darwin, N.T. (*3); East Arm, Darwin Harbour, N.T. (*3); Fannie Bay, Darwin, N.T. (*1); Port Essington, Coburg Penin., N.T. (3 + *1); Yirrkala Mission, N.T. (5); Groote Eylandt, N.T. (2); Gulf of Carpentaria, N.T., at 16°58.5'S, 14 0° 0 0'E, 18m (1) and 14°31.5'S,

141°11.5'E, 26m (*2); Lizard Is., Q. (2); Batt Reef off Port Douglas, Q. (1); Rowes Bay, Townsville, Q. (5); Magnetic Is., Q. (1); Broadhurst Reef, E. of Townsville, Q., 9 m (1); Armit and Crassy Is., Whitsunday group, Q. (3); Lindeman and Little Lindeman Is., Q. (16); S. Molle Is., off Proserpine, Q. (1); Green Is., near Mackay, Q. (1); Crillett Bay, Swain Reefs, Q. (2); Keppel Is. group (5 + *4); Keppel Bay, Q. (1 0); off Port Curtis, Q. (2); off Fairlight, Port Jackson, N.S.W., 3 0 ft (1); Gunnamatta Bay, Port Hacking, N.S.W. (1) (southernmost record, east coast).

Author's collection: Rowes Bay and Kissing Point, Townsville, Q. (18 living specimens).

From localities outside Australia — Australian Museum (Sydney): near Sentosa Is., Singapore; Lord Howe Is.

British Museum (Natural History): Tuticorin Pearl Banks (extreme southeast India).

U.S. National Museum: 6 0 miles SE of Lami, Kenya (2°42'S, 4 0°36'E, 14 0 m, Anton Bruun 8 Sta. 42 0-A).

Museum of Comparative Zoology (Harvard University): Native Jetty, Karachi, W. Pakistan.

Specimens probably, but not certainly, belonging to *P. deltodes* were examined from E. Indonesia (Australian Museum), the Persian Gulf (British Museum), and the Red Sea (U.S. National Museum).

Habitat

Most collections of *P. deltodes* that include habitat records are from a hard substratum, either rock-strewn reefs and flats or coral blocks and heads ("bombies"). In Rowes Bay, Townsville, most individuals were buried upright among cobbles, but one specimen from Kissing Point was found wedged horizontally under a large boulder. The large specimen collected from Broadhurst Reef was found beneath a bombie (Fig. 5). The usual habitat of this species thus may be cryptic, wedged horizontally beneath coral blocks, and the symmetrical shell shape and high, curved posterior margin is perhaps an adaptation to such a horizontal position. The two specimens from the southern bays of New South Wales, one from 30ft, may have been associated with the scleractinian corals that occur there at depth (T. Done, pers. comm.). A description of new collections from the Red Sea at the Rijksmuseum van Natuurlijke Historie (Leiden) lists *P. bicolor* as regularly found associated with living coral (Marstatter, 1978); the species may actually be *P. deltodes*.

The recorded depth range of *P. deltodes* is from the intertidal zone to 140 m.

Types

Rosewater (1961: 199) chose Reeve's figure of *Pinna deltodes* Menke as the type figure; the holotype is presumably lost. The internal shell characters of this figured specimen are like the species described here (Fig. 5). The figured shell may not actually be a syntype, however. According to Solene Morris of the British Museum (letter of 10 November 1978): 'There are two specimens in this lot [of Reeve material]... The larger of the two specimens is the figured one, the other, smaller one, is temptingly close in size to the measurements published by Menke (1843: 37)... According to Dance (1966. *Shell collecting: An illustrated history.* Faber & Faber, London, p. 294): Menke's collection was "acquired by M.J. Landauer and dispersed. For note on coll. see Zilch, 1958 *Arch. Moll.* 87: 53". Zilch also published a photograph of one of Menke's manuscript labels (loc. cit., pl. 4, fig. la). The single questionably original label glued to the smaller of these two specimens is not in Menke's, Cuming's or Reeve's handwriting and none of the labels indicates that the specimens came from the type locality. However, the larger specimen is clearly that figured by Reeve and usually, but not always, he cited the locality ("Hab".) of the specimens. But he could also have quoted the "Hab" from the original description. There is no evidence with the specimens that suggests (to me) that they actually came from Menke, or from the type locality.'

The illustration by Reeve is here considered to be the type figure by subsequent designation (Rosewater, 1961), and the type locality, as given by Menke and Reeve, to be near the Victoria River.

Pinna fimbriatula Reeve from Japan was included by Rosewater as one of the four short, wide forms of *P. bicolor*. However, the suite of shell characters of this species do not place *P. fimbriatula* unequivocally in either *P. bicolor* or *P. deltodes:* it has coarse spines, a wide sulcas, and a posterior adductor muscle that touches or almost touches the dorsal edge of the dorsal nacreous lobe. These three character states place it closest to *P. rugosa* Sowerby of the eastern Pacific and the Atlantic species *P. rudis* Linne, but its definite placement is left open. The holotype is in the British Museum (Natural History).

The holotypes of both *Pinna scapula* Hedley and *Exitopinna deltodes ultra* Iredale in the Australian Museum (Sydney) have been examined by me and are not distinguishable from *P. deltodes*.

COMPARISON OF *PINNA DELTODES* AND *PINNA BICOLOR*

A total of 32 specimens of *P. deltodes* and 28 specimens of *P. bicolor* with soft parts and shells were examined for nonoverlapping character states. The specimens of *P. deltodes* were from seven localities between Darwin, N.T. and the Keppel Island group in the southern Great Barrier Reef (Table 1). *Pinna bicolor* specimens came from ten localities with a broader geographic range: Denham, W.A., across northern Australia, along the east coast of Queensland and New South Wales, and Kangaroo Island, S.A. Four of the localities provided wet specimens for both species.

Differences in the distribution of gland cells along the inner mantle fold distinguish *Pinna deltodes* from *P. bicolor* (Fig. 1) and correlate with differences in position of the posterior adductor muscle scar in relation to the dorsal nacreous lobe (Figs. 4, 7, 8).

Posterior Mantle Margin

In *P. deltodes*, subepithelial unicellular gland cells are aggregated in regular, sharply defined, pinkish-buff lateral bands along the inner fold of the posterior mantle margin and in masses throughout the mantle posterior to the waste canal (Figs. 1, 2, 3). These gland cells are packed with coarse granules that do not stain with Alcian blue and are negative to periodic-acid-Schiff treatment (PAS), that is, they are not acid or neutral mucopolysaccharides (mucins) or muco-or glycoproteins (mucoids). The granules stain brilliantly with Orange G in a modified Gomori's trichrome, a test for erythrocytes in mammalian tissue, and thus may be formed of a basic protein. Each rounded or irregularly shaped cell contains a large vacuole (Fig. 3B); the cell membrane is not distinct. In serial sections none of these cells were found to empty through the epithelium to the outside, and their function is not known. Besides the aggregates of gland cells visible to the naked eye, single cells or small groups of cells are scattered throughout the posterior mantle lobe, at the tip of the outer fold, and along the inner surface of and within the middle fold (Fig. 3A).

Pinna bicolor also has granular gland cells with the same staining properties scattered densely throughout the posterior mantle lobe; they are aggregated into distinct bands within the lobe but not along the inner mantle fold (Fig. 1B). Small specimens of *P. bicolor* may rarely have diffuse, pale-buff bands along the inner mantle fold, but in large specimens, even from the same locality as the small banded specimens, these bands do not occur. On the other hand, the very distinct bands of *P. deltodes* are present in specimens only 9 cm long and are obvious to the naked eye in the field when the valves are gaping (Fig. 2).

Two other species of Pinnidae and three closely related pteriomorph species were examined histologically for similar basic granular gland cells. Both *Atrina vexillum* (Born) and *Streptopinna saccata* (Linne) contained a few of these gland cells scattered sparsely throughout the posterior mantle lobe, but *Pinctada* sp., *Isognomon epiphippium*, and *Isognomon* sp. lacked any gland cells that stained with Orange G. Dix (1972) did not report

gland cells of this type in a careful histochemical study of secretory cells in the mantle of *Pinctada maxima* (Jameson).

Shell

The pattern of the nacreous layer and the position of the posterior adductor muscle scar determine generic, subgeneric, and species membership in the Pinnidae (Turner and Rosewater, 1958; Rosewater, 1961); unique to the genus *Pinna* is the sulcus which divides the nacreous area into dorsal and ventral lobes (Fig. 4).

In all wet specimens of *P. deltodes* examined (Table 1), the posterior adductor muscle scar was found to touch the posterior edge of the dorsal nacreous lobe (Figs. 4A, 5, 6, 7), whereas in *P. bicolor* shells with soft parts, the posterior adductor muscle was always found to lie within the dorsal nacreous lobe (Figs. 4B, 8; see also Rosewater, 1961, Figs. 147, 148, 151-153). Subsequent examination of all *P. bicolor* and *P. deltodes* shells in several museums showed no overlap of these two character states in specimens from Australia. However, identity of shells from the Indo-Pacific north and west of Australia is often ambiguous; the posterior adductor muscle scar almost, but not quite, reaches to the posterior edge of the dorsal nacreous lobe in specimens that otherwise appear to belong to *P. deltodes*.

There are other character states of the shell which usually separate the two species in Australia. *Pinna deltodes* does not attain as great a size as *P. bicolor;* the largest shell known (Fig. 6) is 125 mm shorter than 495 mm recorded for a large *P. bicolor* (Rosewater, 1961). Spines sometimes occur on shells of *P. bicolor,* but not *P. deltodes*. The colour of *P. bicolor* is variable, including horn in specimens from the south coast of Australia; *P. deltodes* is always a horn colour.

Although shell-shape is markedly variable in both species, each has a common and distinct shape with *P. deltodes* usually nearly symmetrical and *P. bicolor* typically asymmetrical (Fig. 4). The difference in shape can be expressed (1) by the ratio between the length of the dorsal posterior margin and longest shell length, more than twice as great in *P. deltodes* as in *P. bicolor,* and (2) by the shorter dorsal margin of *P. deltodes* relative to longest shell length (Table 2; Fig. 4). The width of shells is about one-half the shell length in *P. bicolor* and nearly three-quarters the shell length in *P. deltodes*. The posterior adductor muscle scar of *P. deltodes* lies anterior to the mid-point of the shell in more than one-half the specimens examined, whereas in nearly all *P. bicolor* shells the posterior adductor lies further posteriorly than the mid-point (Table 2, expressed as the ratio between the length of anterior to posterior adductor and the length of the posterior adductor to posterior shell margin; the mid-point position is 1.00). The greater shell width of *P. deltodes* is reflected internally in the greater width of the sulcus between the nacreous lobes, on average twice as wide as in *P. bicolor*. Length of the ventral nacreous lobe relative to the dorsal lobe distinguishes the Atlantic species *P. rudis* and *P. carnea,* but this character is variable in both *P. deltodes* and *P. bicolor*.

Marked differences in shell shape are not present in shells less than about 12 cm in length.

Habitat

Although *P. bicolor* occurs with both *P. deltodes* and *Atrina vexillum* on the mixed sand and cobble flats in Townsville, Qld., it is most often reported from finer sediments. Unlike *P. deltodes, P. bicolor* may form extensive beds either intertidally on sand and mud flats (Womersley and Edmunds, 1958, pl. 10, fig. 2) or subtidally (Butler and Brewster, 1979), often with sea-grass or along edges of mangroves. Depth records for *P. bicolor* are shallower than for *P. deltodes;* the deepest *P. bicolor* record is 15m from Ship Rock, Port Hacking, N.S.W. (coll. Australian Museum), less than the records of 18 and 26m in the Gulf of Carpentaria and 140m off Kenya for *P. deltodes*.

Growth

Length-frequency distributions of *P. deltodes* (N = 18) and *P. bicolor (N* = 12) collected randomly from the sparse populations present on the cobble flat in Rowes Bay, Townsville,

in May 1978 were compared with those published for *P. bicolor* in South Australia over a three-year period (Butler and Brewster, 1979). Although the sample sizes from Townsville are very small, the data are suggestive and some conclusions can tentatively be made about these intertidal populations.

There was no specimen of *P. bicolor* greater than 16.4 cm, with the modal length lying between 12.0 and 14.0 cm (Fig. 9). Butler and Brewster (1979) ascertained that the greatest size attained by the 0-year-class in South Australia is nearly 20 cm, and that a modal length of 13-14 cm was already reached or surpassed by February in three different years. It is therefore inferred that the Rowes Bay population is lost during the summer monsoons and re-established regularly by larval recruitment during the late summer. If length-frequency data of *P. deltodes* from Rowes Bay are compared with those of *P. bicolor*, the modal length of the 0-year-class is seen to be less, between 10 and 12 cm (Fig. 9). As *P. deltodes* is a smaller species than *P. bicolor*, the second peak of *P. deltodes* at 20-22 cm perhaps represents a 1-year-class in Rowes Bay.

ACKNOWLEDGEMENTS

Dr. Winston F. Ponder first pointed out to me the possibility that *Pinna deltodes* is a distinct species and graciously made available the resources and collections of the Australian Museum. Mr. Ian Loch of that Museum was extremely helpful in providing access to the collection and arranging for photography. Mrs. Shirley M. Slack-Smith of the Western Australian Museum re-examined that collection in the light of the findings presented here and provided a list of the holdings. I thank Dr. John Taylor of the British Museum (Natural History) for his kindness and Mrs. Solene Morris for her great help in investigating the status of Reeve type material and arranging for photography. Dr. Joseph Rosewater of the U.S. National Museum has shared his extensive knowledge of the Pinnidae, and he and Dr. Ruth D. Turner of the Museum of Comparative Zoology, Harvard University, made their collections available. Mr. Leigh Winsor of James Cook University patiently guided me in the uses of histochemistry, suggested Gomori's trichrome as a useful test, and made histologic sections. Finally, I would like to acknowledge the support of Rudolf S. Scheltema, with whom I spent a splendid sojourn in Australia where he was a Senior Fulbright Exchange Scholar and where most of the work in this paper was accomplished; the use of the facilities at Games Cook University is gratefully acknowledged.

LITERATURE CITED

Butler, A.J. and F.J. Brewster. 1979. Size distributions and growth of the fan-shell *Pinna bicolor* Gmelin (Mollusca: Eulamellibranchia) in South Australia. Aust. J. Mar. Freshwater Res. *30:* 25-39.

Dix, T.G. 1972. Histochemistry of mantle and pearl sac secretory cells in *Pinctada maxima* (Lamellibranchia). Aust. J. Zool. *20:* 359-368.

Marstatter, M. 1978. The marine molluscan assemblages of Port Sudan, Red Sea. Zoologische Mededelingen *53:* 117-144.

Rosewater, J. 1961. The family Pinnidae in the Indo-Pacific. Indo-Pacific Mollusca *1*(4): 175-226.

Turner, R.D. and J. Rosewater. 1958. The family Pinnidae in the western Atlantic. Johnsonia *3*(38): 285-326.

Womersley, H.B.S. and S.J. Edmonds. 1958. A general account of the intertidal ecology of South Australian coasts. Aust. J. Mar. Freshwater Res. *9:* 217-260, pls. 1-2.

Table 1. Geographic distribution of specimens with soft parts examined for *Pinna deltodes* and *P. bicolor*.

Locality	Number of specimens *P. deltodes*	*P. bicolor*
Woodman's Pt., Fremantle, W.A.	—	1
Denham, W.A.	—	3
East Arm, Darwin Harbour, N.T.	3	1
West Point, Darwin, N.T.	3	—
Fannie Bay, Darwin, N.T.	1	—
Pt. Essington, Coburn Penin, N.T.	1	1
Gulf of Carpentaria	2	—
Rowes Bay, Townsville, Q.	18	12
Keppel Is. group, Q. (see Figs. 7 and 8)	4	1
Tin Can Bay, NE of Gympie, Q.	—	1
Moreton Bay, Q.	—	2
Port Hacking, N.S.W.	—	1
Kangaroo Is., S.A.	—	5
Total	32	28

Table 2. Means and ranges of shell measurements and their ratios in selected *Pinna deltodes* and *P. bicolor* shells.

Measurement or Ratio*		*P. deltodes*	*P. bicolor*
dorsal post. margin (3) : length (6)	$\bar{X}$	0.48	0.21
	Range	0.57-0.90	0.08-0.37
	N	8	9
width (5): length (6)	$\bar{X}$	0.69	0.50
	Range	0.52-0.89	0.36-0.75
	N	8	13
dorsal margin (4) : length (6)	$\bar{X}$	0.72	0.95
	Range	0.56-0.93	0.78-1.04
	N	8	9
ant. to post. adductor (1): post. adductor to post. shell margin (2)	$\bar{X}$	1.03	1.18
	Range	0.65-1.44	0.74-1.62
	N	31	21
width of sulcus in mm (7)	$\bar{X}$	0.5	0.25
	Range	0.3-1.0	02-0.5
	N	24	15

*Refer to Figure 4 for key to measurement number.

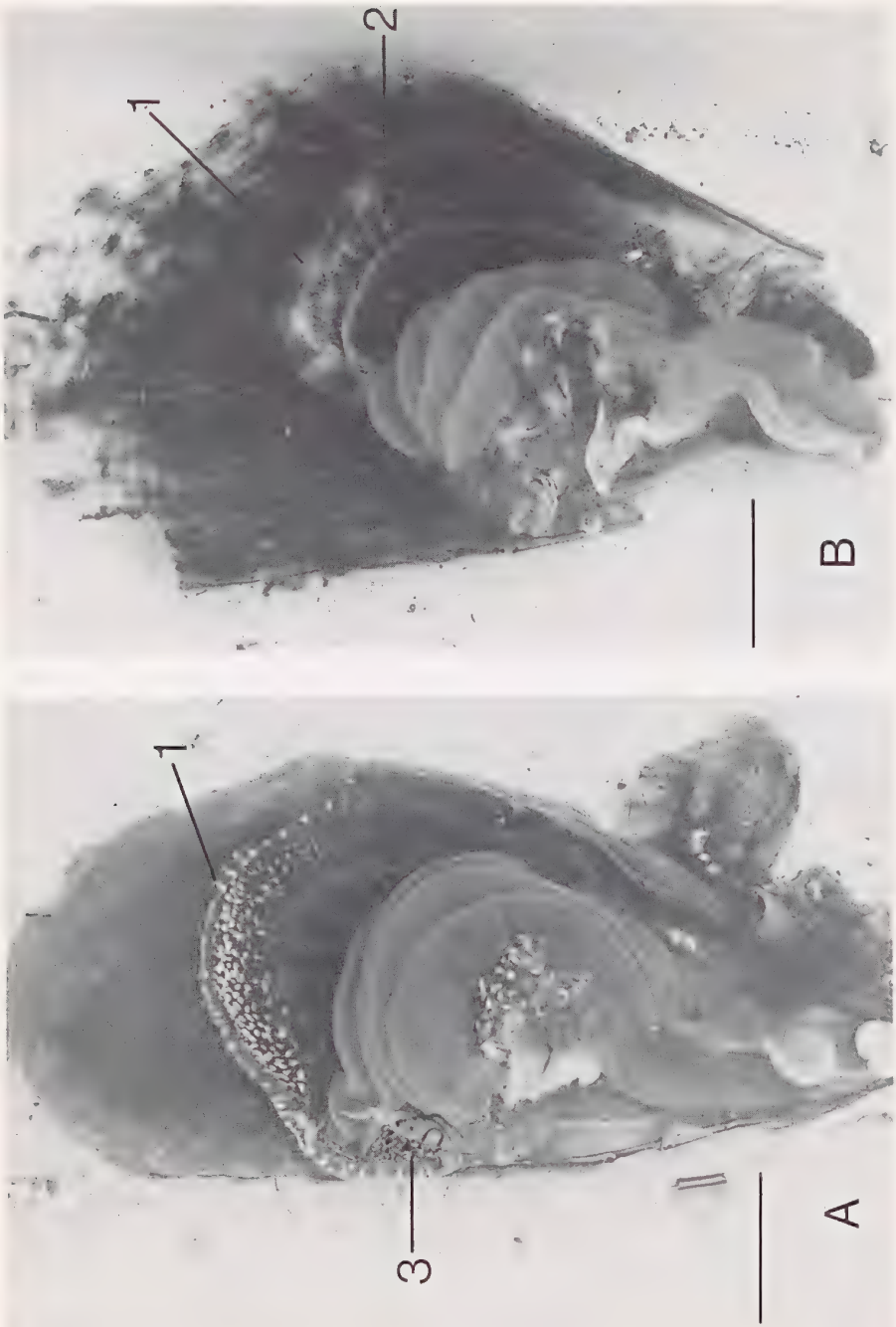

Fig. 1. A. *Pinna deltodes* Menke and B. *Pinna bicolor* Gmelin; left valves removed to show the distribution of bands of mantle gland cells. Rowes Bay, Townsville, Qld.: 1 — inner mantle fold; 2 — gland cells in posterior mantle lobe; 3 — pallial organ. Scale = 3 cm.

Fig. 2. *Pinna deltodes* with gaping valves, in situ, Rowes Bay, Townsville, Qld. showing sharply defined bands of gland cells along the inner fold of the posterior mantle margin. Scale = 5 cm.

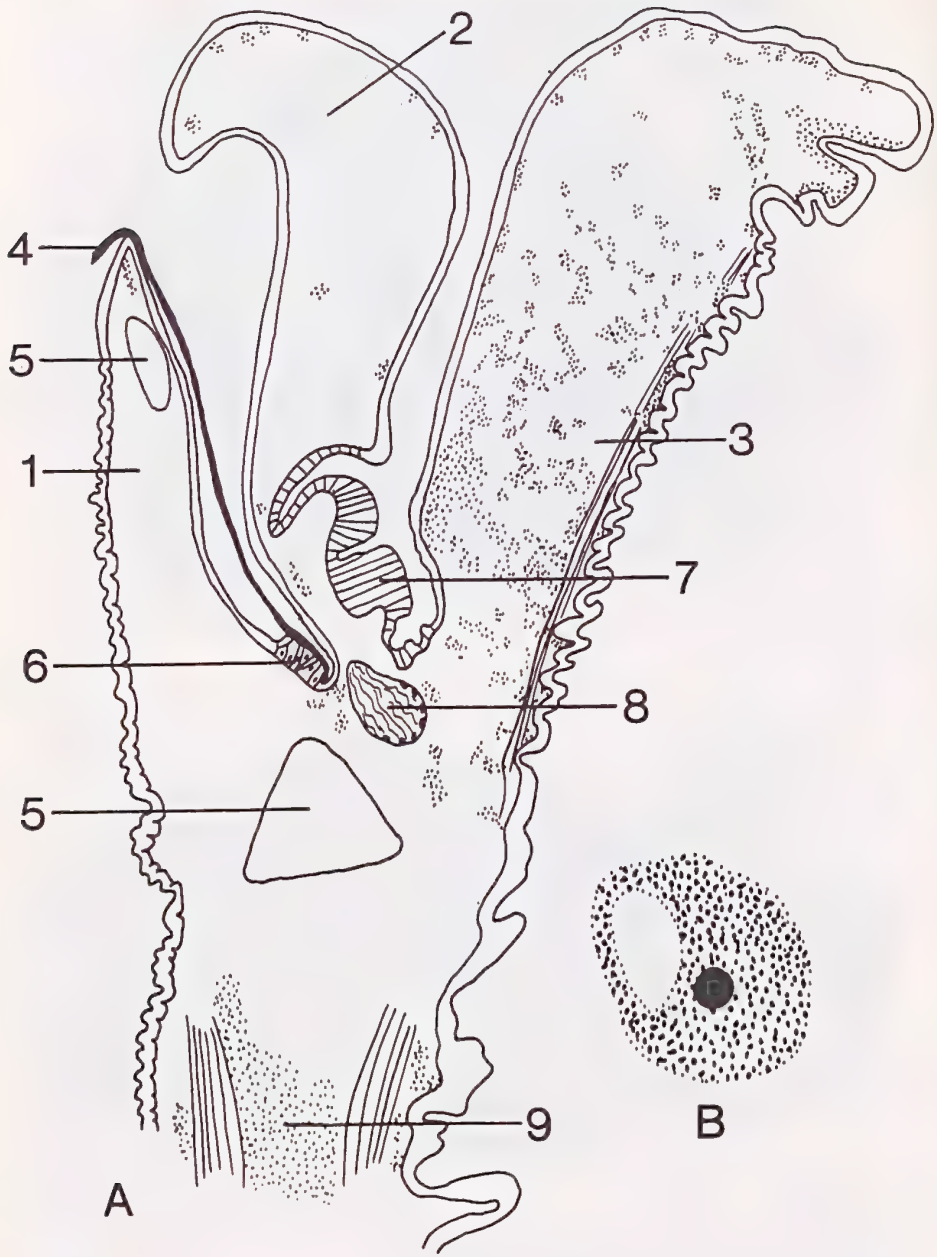

Fig. 3. A. *Pinna deltodes*, cross-section through glandular band of inner mantle fold; stipples indicate gland cells. B. single gland cell. 1 — outer mantle fold; 2 — middle mantle fold; 3 — glandular inner mantle fold; 4 — periostracal sheet, thickness exaggerated; 5 — blood vessel; 6 — basophilic, periostracum-secreting epithelium; 7 — 'eye of Will'; 8 — pallial nerve; 9 — glandular area of posterior mantle lobe.

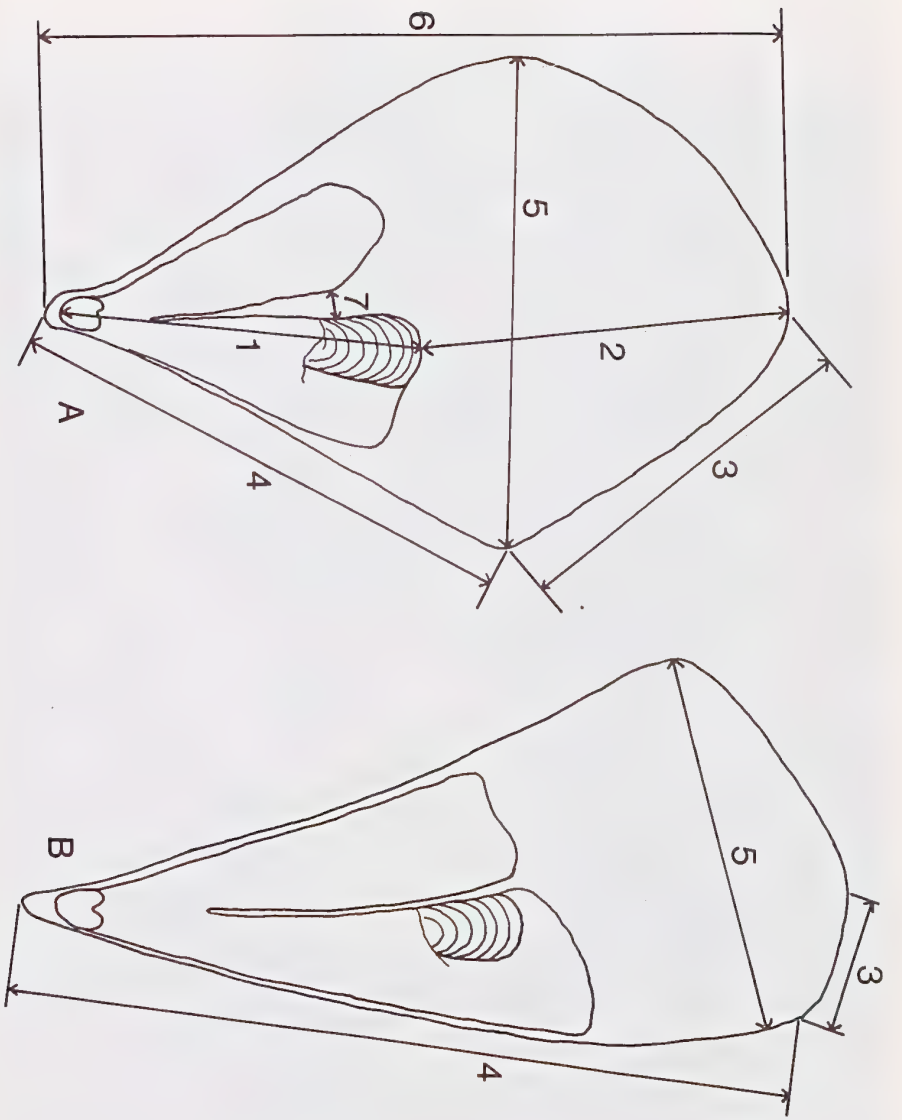

Fig. 4. Inside left valves of *Pinna deltodes* (A) and *P. bicolor* (B) showing position of nacreous lobes and posterior adductor muscle scars, indicated by concentric lines. Measurements are those referred to in Table 1: 1 — anterior to posterior adductor; 2 — posterior adductor to posterior shell margin; 3 — dorsal posterior margin; 4 — dorsal margin; 5 — width; 6 — length; 7 — width of sulcus.

Fig. 5. Internal view of left valve of *Pinna deltodes* Menke 1843 figured by Reeve (1858), subsequently designed as type figure by Rosewater (1961); dorsal margin at right, posterior margin at top; cf. Fig. 4. Scale in cm. (British Museum [Natural History] 1952.9.15.1. Photograph by Mr. Jim Brown, by permission of the Trustees of the BM[NH].)

Fig. 6. Outer right and inner left valve surfaces of large specimen of *Pinna deltodes* with typical shell shape. Broadhurst Reef east of Townsville, Qld., 9 m under ledge of bombie. Scale 3 cm. (Aust. Mus. c.104655. Photographs by courtesy of the Australian Museum.)

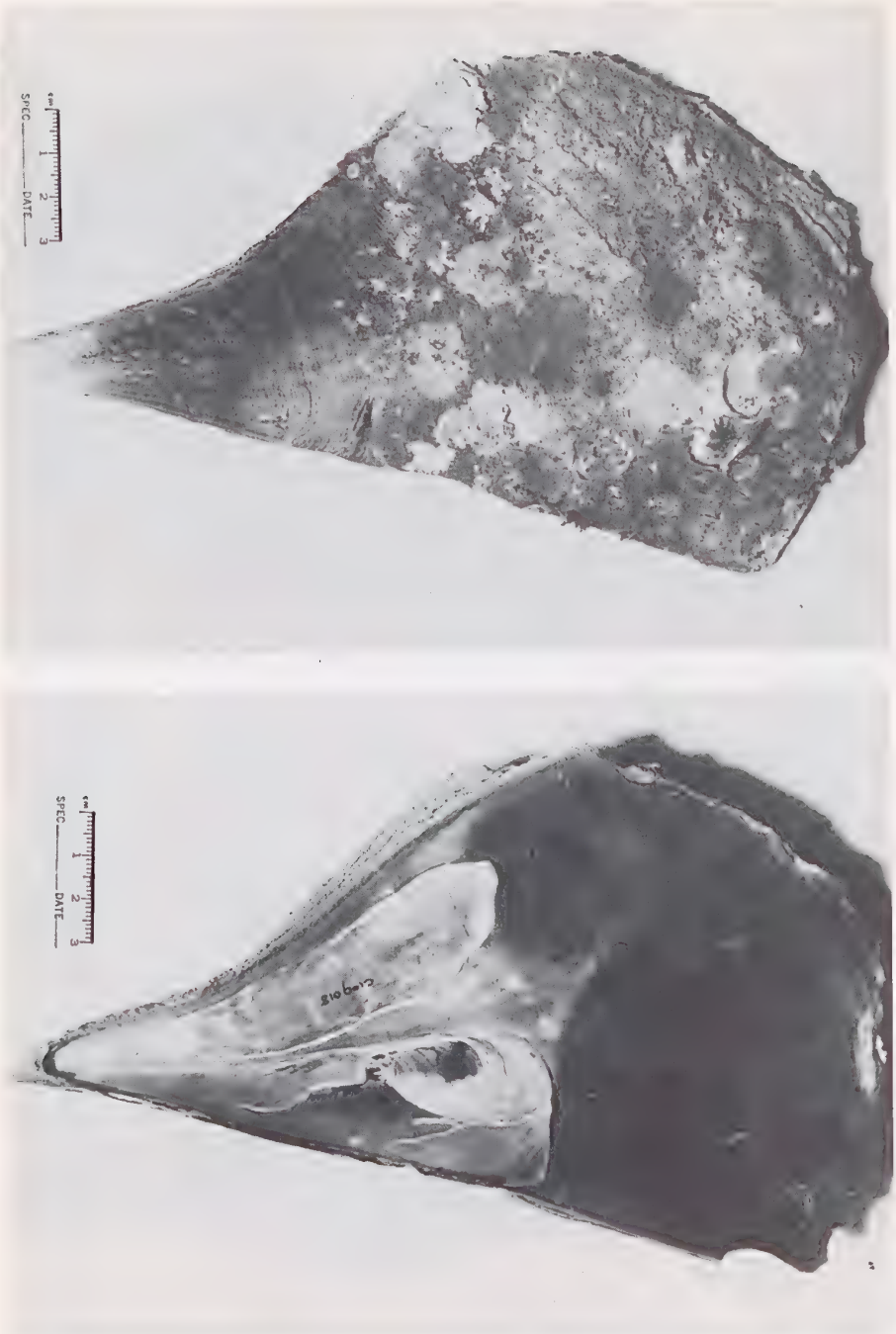

Fig. 7. Outer right and inner left valve surfaces of *Pinna deltodes*, south end of Keppel Is., Qld. Soft parts and histologic sections of mantle edge examined. Scale 3 cm. (Aust. Mus. c.109018. Photographs by courtesy of the Australian Museum.)

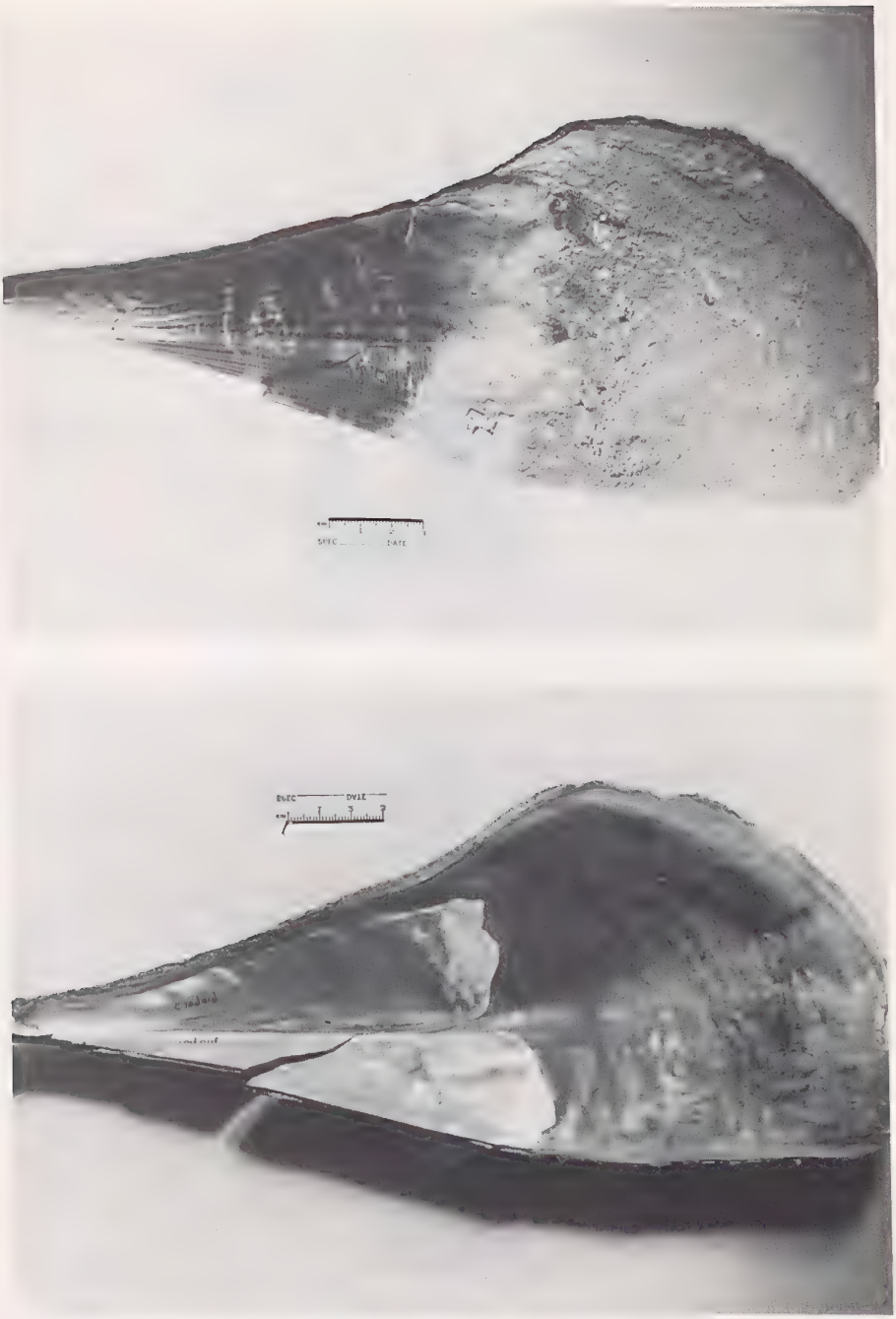

Fig. 8. Right valve of *Pinna bicolor* showing outer and inner surface, south end of Keppel Is., Qld. Soft parts and histological sections of mantle edge examined. Inner view is reversed image of right valve. Scale 3 cm. (Aust. Mus. c.109019. Photographs by courtesy of the Australian Museum.)

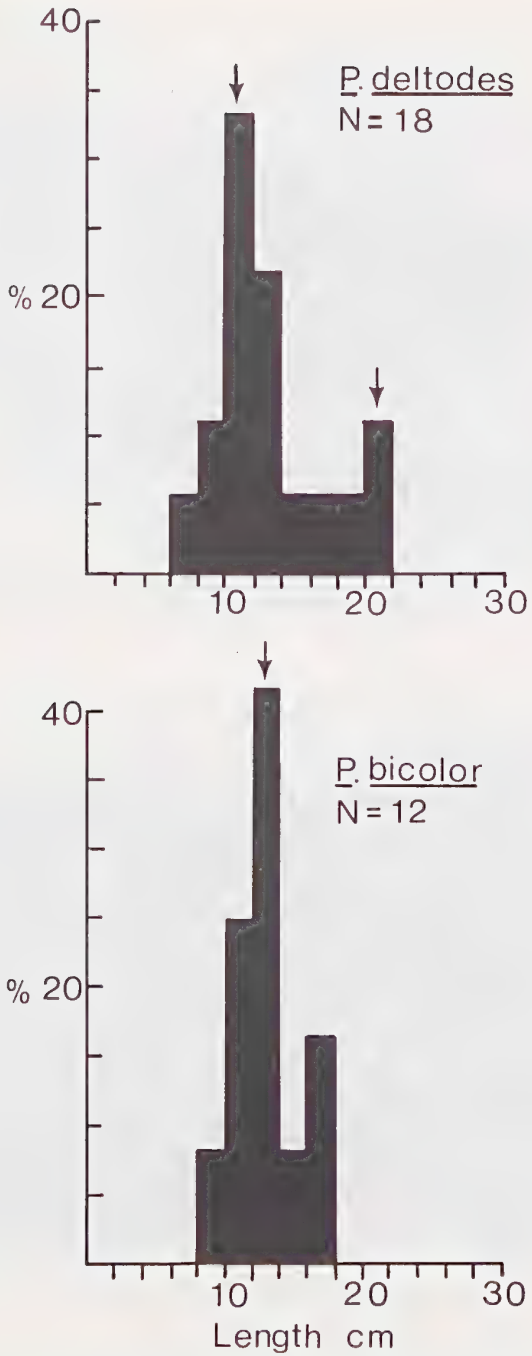

Fig. 9. Length-frequency distribution of *Pinna deltodes* and *P. bicolor* on flats in Rowes Bay, Townsville, Qld., May 1978.